URBAN PLANNING AND WATER CORRIDORS. A CASE STUDY OF INTEGRATION OF THE HYDROLOGICAL CHARACTERISTICS INTO THE SITE LAYOUT.

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Abstract

Urban planning is a non-structural measure of paramount importance in regards of flood risk management, therefore it should not only be considered when analyzing fluvial flooding but an assessment on pluvial flooding should be undertaken at the planning stage of any development. Nowadays precipitation-runoff modeling can easily identify the areas at greatest risk to pluvial flooding within a site, and these results can be used to produce an infrastructure layout that takes into account and maintains/recreates the existing 'blue corridors' (receptors and pathways).

The Soterranyes site in Vinaròs, Spain, is an industrial development which main design objectives are the respect for the environment and its integration in the surrounding landscape. The analysis of the natural hydrology (with the use of Micro Drainage software, Win*Des*®) has allowed to develop a plan layout that respects a dry ravine as a natural limit of the site, and integrates the main internal water corridors along the transport lines, away from the industrial plots. Additionally, Sustainable Drainage Systems (SuDS) are employed to manage stormwater in a way that mimic the natural hydrology. Although this article focus on a case study, concepts and ideas exposed herein have general applicability to other industrial, commercial and residential developments.

Stormwater and Floods Legislation

European Floods Directive [1] requires Member States to prepare preliminary flood risk assessments to identify areas that are at potentially significant flood risk, by 20 December 2011, on the bases of which flood hazard maps and flood risk maps will have to be completed by 22 December 2013. Based on them, Member States shall complete and publish flood risk management plans by 22 December 2015. All these deliverables shall be made available to the public, and Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans.

This Directive applies to all kind of floods, defining 'flood' as 'the temporary covering by water of land not normally covered by water. This hall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and

may exclude floods from sewerage systems'.

In Spain, The European Floods Directive was incorporated into national law with the "Real Decreto 903/2010 [2]", which came into force on 16th July 2010. However, some related instruments had been already legislated by the "Real Drecreto 9/2008 [3]", through which the 'Flood Prone Areas Cartographic National System' (*Sistema Nacional de Cartografía de Zonas Inundables, SNCZI*) was created. Works are currently in progress, but they are focussed on fluvial flooding, and its interaction with the sea in coastal areas.

At regional level, in the Valencian Region there is already an approved plan to prevent flood risks, called PATRICOVA [4], which includes flood hazard maps (scale: 1:50.000), but only related to the main river courses (both of continuous and intermittent character, but with a minimum width of 3 m and of 0.5 km^2 drainage area). This piece of legislation imposes restrictions to urban planning in the areas identified as being possibly affected by floods, and establishes requirements for buildings in those areas. In general, a flooding study (considering values of annual exceedance probability of up to 1/500 years) is required prior to planning/construction permit, but only fluvial flooding is considered (not pluvial flooding). In regards to drainage systems, this legislation only refers to the ones in urban zones which surface area is greater than 100 Ha, specifying that they shall be designed with a protection level of 1/15 years annual exceedance probability at the minimum. This figure is of the same order of magnitude of those considered in most of the Spanish municipal stormwater ordinances, which contemplate annual exceedance probabilities between 5 and 25 years for the design of urban drainage systems.

More recently, in May 2010, the 'Special Plan in view of Flood Risks in the Valencia Region' [5] was approved. Its objective is to guarantee a quick, efficient and coordinated action of public or private resources in emergency situations due to flooding, and to minimise their consequences. This plan obliges those municipalities that are on high or medium flooding risk, and those affected by Dam Safety Plans, to elaborate a Municipal Action Plan. When defining the types of flooding, it estates that local flooding zones originated form torrential rain have not been considered, due to the fact that they can affect any part of the territory, although highlighting their severity in urban areas.

As it can be noticed, current legislation in the Valencian Region and generally in Spain, does not consider risks due to pluvial flooding for annual exceedance probabilities greater than 1/25 years (or whichever is the design return period of the drainage system for a given municipality). However, pluvial flooding can have severe consequences. As an example, rain fallen on 18th May 2011 in Cañete de las Torres (Córdoba, Spain), had the tragic balance of one person dead, 150 houses evacuated and 100 houses left uninhabitable. Water levels rose up to 2 m, flooding garages, basements, commercial premises and dwellings.

Proposed approach for Spanish urban planning

Even though it is understandable that priority is given to fluvial flooding studies at national and regional level, undertaking pluvial flooding assessments at local level, and introducing the outcomes in urban planning, is a non-structural measure of paramount importance in regards of flood risk management. Therefore, both fluvial and pluvial assessments should be undertaken at least at the planning stage of any development, in view of preventing damage caused by floods to people, goods and the environment.

This is not new in other parts of Europe. In the UK, flood risk assessments both for pluvial and fluvial flooding are compulsory for new developments. The document “Sewers for Adoption” (the Industry Standard for England and Wales) [6] indicates that the drainage system should be design not to flood any part of the site for a 1:30 year return period design storm, and for extremely wet weather, checks should be made to ensure that an adequate level of protection against flooding of properties internally is achieved and design adjusted where the reqired flooding protection is not achieved. “Seers for Scotland” [7] specifies that checks for 1-im-100 and 1-in-200 year return period must be undertaken to ensure properties on and off site are protected against flooding, and the design must demonstrate flow paths and the potential effects of flooding.

Nowadays technology enables detail analysis of a site ground profile, and precipitation-runoff modeling can easily identify the areas at greatest risk to pluvial flooding within a site. This allows flood mitigation measures to be implemented within the outline design, rather than costly remediation measures at a later stage. Later on in the design process, once the drainage system has been designed, overland flood routing for the extreme rainfall events (behind the design criteria) must be controlled. It is where the water goes (both on and off a site) that can determine the viability of proposed developments.

Soterranyes Case Study

Project characteristics and objectives

The Soterranyes site, which occupies an area of approximately 220 ha, is located within the municipality of Vinaròs (Castellón province, Spain), 7 km West of the city centre, adjacent to N-232 road and very close to A-7 motorway. The predominant use of the area is agricultural dry land, although most of the fields are abandoned at present. A dry ravine forms the Southern limit of the site.

Council of Vinaròs, the public developer, want to offer an appropriate space for the establishment of medium and big enterprises, which at present is not available in the area, but making development choices that protect the environment. For this reason, the main objectives set up for the project are the respect for the environment and its integration in the surrounding landscape.

In this line, the following aspects have been given special attention in regards of stormwater:

- -Protection of the dry ravine “El Peturrero”;
- -Adaptation of the road infrastructure and plot distribution to the existing terrain, taking into account stormwater runoff corridors;
- -Stormwater management using Sustainable Drainage Systems (SuDS), in order to mimic the natural hydrology of the site;
- -On purpose legislation to specify how the plots have to participate on the sustainability of the whole development (with the same principles as per the public areas).

Water corridors and layout adaptation

Taking the original area reserved for the development (yellow line in Figure 1), development is restricted to a smaller area (pink line in Figure 1), respecting the main dry ravine as a natural limit of the site. Blue lines represent ephemeral water courses, and the white lines depicture proposed transport lines (explained later on the article).

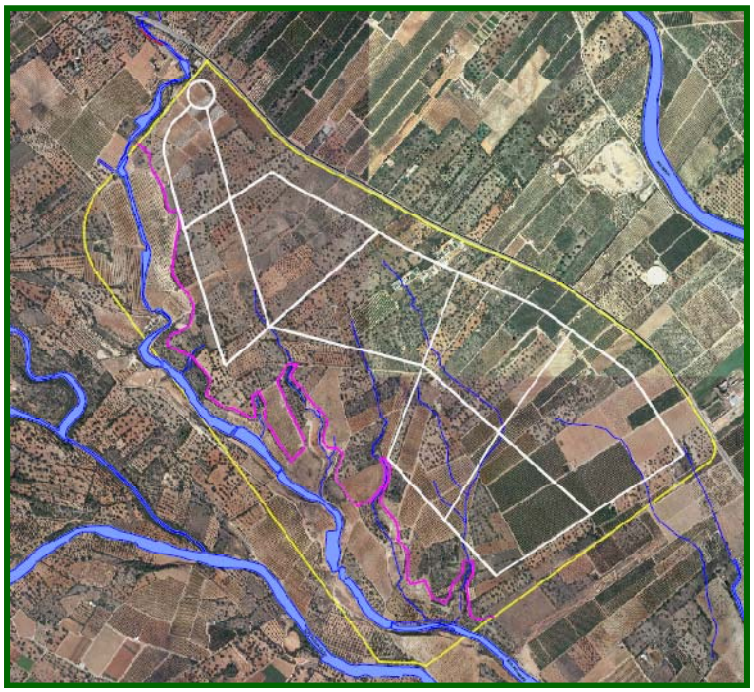

Figure 1: Soterranyes Industrial Development Sit

The 220 ha of Soterranyes Industrial Development are planned to be developed within four phases, first of which accounts for nearly a third of it (63 ha). In this Phase 1, detail design has been completed, and the processed followed is explain herein.

The analysis of the natural hydrology for the Phase 1 has been analysed with the use of Micro Drainage software, Win*Des*®. Figure 2 (left) shows the main water corridors. This initial assessment has allowed developing a plan layout that respects the dry ravine ("El Peturrero", the deepest ravine to the left of the image) as a natural limit of the site, and integrates the main internal water corridors along the transport lines, away from the industrial plots, as it can be viewed in Figure 2 (right).

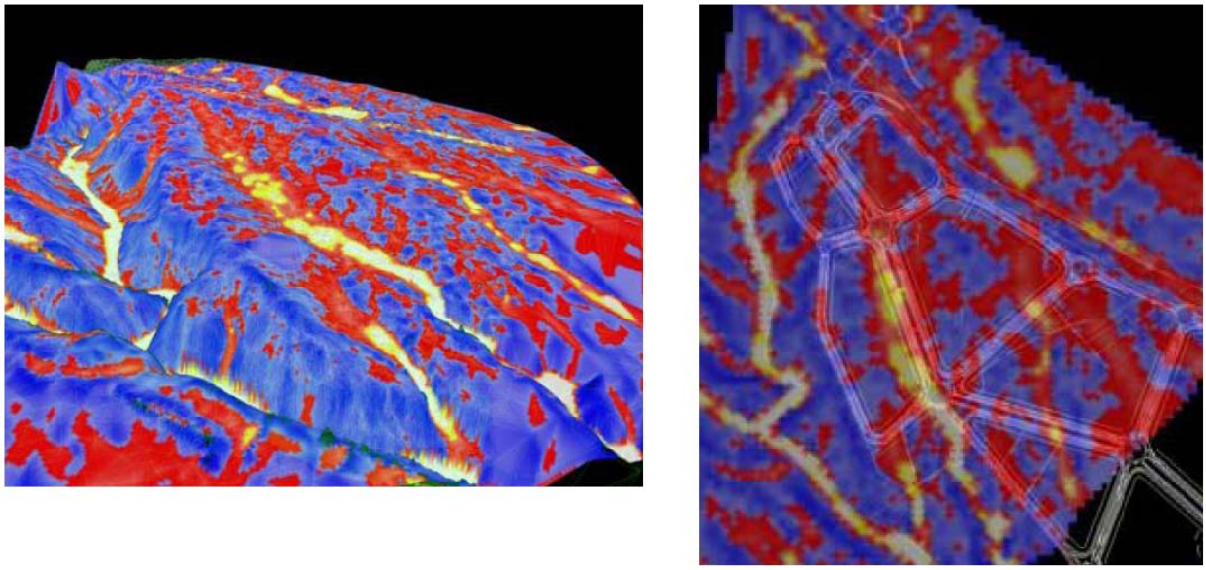

Figure 2: Natural Hidrology for Phase 1 of the Soterranyes Industrial Development, and site layout accommodating water corridors into the main roads and plot distribution

Drainage design

Once the site layout had been defined accommodating the main water corridors, next step was to design the stormwater infrastructure. It was decided to employ Sustainable Drainage Systems (SuDS), in order to address the three essential issues of quality of surface water runoff, quantity of runoff and amenity (including biodiversity), in a way that mimic the natural hydrology. These three key considerations for a holistic approach to urban runoff have been given equal weighting.

Implementation of SuDS in Spain is at a very preliminary stage [8], but they were selected thanks to the desire of Council of Vinaròs of making development choices that protect the environment. In addition to the benefits of conventional end-of-pipe facilities (reduction of some pollution and flow rate control during large storm events), SuDS have the ability to mitigate runoff volume, restore natural base flow, promote groundwater recharge and provide more water treatment, amongst others, with the added value of multi-functionality of the hydraulic infrastructure (by integrating it into the development landscape) [9]. Types of SUDS included into the designed are: bioretention zones, detention basins, filter strips, flow control systems, permeable paving and swales. Figure 3 depictures the final design for Fase 1, and as an example, Figure 4 shows how filter strips and a big swale have been integrated on the main site transport corridor.

Figure 3: Proposed site layout

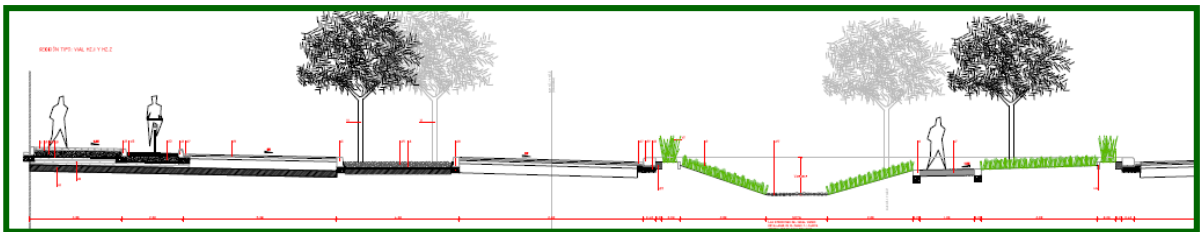

Figure 4: Cross section of the main road, integrating a current runoff corridor into the site layout

SuDS are employed to manage stormwater in a way that mimic the natural hydrology (both in terms of quantity and quality), not increasing the runoff that discharges into the ravine. The drainage system has been designed with a protection level of 1/15 years annual exceedance probability, and using UK legislation as a guidance, it has been checked that for a storm of 1:100 years return period, water flows under control along the roads and discharges into the ravine without causing damage to the plots. The site design is complemented with regulations and maintenance programs for both the public and the private space.

Other aspects of the project

Within the spirit of the European Floods Directive (which reinforces the rights of the public to access this information and to have a say in the planning process), and following Spanish regulations, two information meetings have taken place so far, where the general public was able to access the planning information and had the opportunity to comment on it. Additionally, a web site has been available for general public consultation, which includes a questioner to be completed and submitted to the design team.

Conclusion

Urban planning is a non-structural measure of paramount importance in regards of flood risk management, therefore it should not only be considered when analyzing fluvial flooding but an assessment on pluvial flooding should be undertaken at the planning stage of any development. Nowadays precipitation-runoff modeling can easily identify the areas at greatest risk to pluvial flooding within a site, and these results can be used to produce an infrastructure layout that takes into account and maintains/recreates the existing 'blue corridors' (receptors and pathways). Although this article focus on a case study, concepts and ideas exposed herein have general applicability to other industrial, commercial and residential developments.

Acknowledgements

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